REPORTS
The National High Magnetic Field Laboratory
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Advanced Power Systems Focus of New R&D Center at Laboratory

The U.S. Office of Naval Research has awarded Florida State University $10.9 million over three years to establish a program in advanced power systems that will support the Navy's all-electric ship program.

The all-electric ship is expected to increase the affordability, reliability, and military capability of the fleet. The major benefits are achieved through reduced maintenance, reduced manning, automation, and design flexibility. Electric systems are easier to reconfigure, enabling the quick insertion of new technology and increasing the life of the ship platform.

The program will be conducted by FSU's Center for Advanced Power Systems, which is focused on research and development of advanced electrical power systems for transportation and utilities. The center builds on the expertise of the National High Magnetic Field Laboratory in high field electro-magnetics, materials, and superconductivity, FSU, and the FAMU-FSU College of

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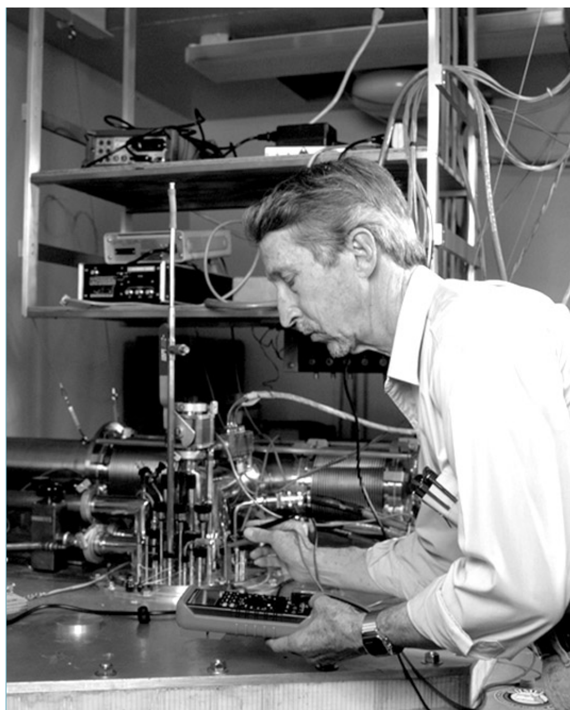
University of Florida Physics Professor Dwight Adams Low-Temperature Thermometry Scale to be Adopted

At the start of his career over 30 years ago, E. Dwight Adams, a member of the NHMFL extended family at UF, and one of his first graduate students, Richard Scribner, suggested a new method of thermometry for measuring temperatures near absolute zero. The method was made possible by the Straty-Adams pressure gauge that he and another graduate student, Gerald Straty, had invented a year earlier. In September 2000, the International Committee on Weights and Measures is expected to accept the recommendation of its *Comite Consultatif de Thermometrie* that the method be adopted as the world's official standard for measuring extremely cold temperatures.



UF Physics Professor Dwight Adams checks connections to a Straty-Adams gauge used to measure ultra-low temperatures.

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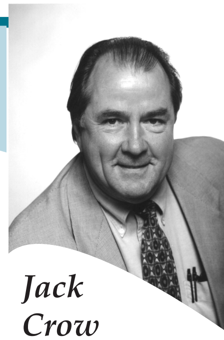
From the Director's Desk



Jack Crow

Ten years ago, on August 17, 1990, the National Science Foundation announced its decision to establish a new national high field magnet laboratory in the United States.

The winning consortium comprising Florida State University, the University of Florida, and Los Alamos National Laboratory had presented a new vision for high field research: It would be broadly multidisciplinary, have a uniquely powerful infrastructure, have a world-class magnet development team building state-of-the-art systems in response to user needs, support unique user capabilities at its three sites, and have commitments from the State of Florida and the participating institutions.

The National High Magnetic Field Laboratory was about to be born.

The laboratory will be commemorating the occasion in August by honoring two people who were critical to laying the groundwork for a magnet laboratory in the State of Florida: Dr. William G. Moulton, former director and founder of FSU's Center for Materials Research and Technology (MARTECH) and Dr. Charles F. Hooper, Jr., former director and founder of UF's (MICROFABRITECH®). In the mid-1980s, the Florida legislature was preparing to fund a materials research center at the University of Florida. Dr. Moulton, in collaboration with Dr. Hooper, was extremely instrumental in getting the legislature to focus on establishing a similar research center at FSU. In the end, both centers were established, the partnership between the universities began, and the team that would become the NHMFL started to take shape. These efforts provided the critical underpinning of new faculty in condensed matter sciences that put the two universities in a competitive position.

Fast forward five years to 1995: The laboratory in Tallahassee has been built (under budget and on time); the first world-record magnets have been built and installed; the facility is fully open to users; a distinguished faculty has been recruited. The NHMFL had become a world-class laboratory.

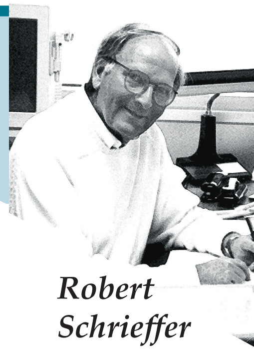
Fast forward again to 2000: The NHMFL is clearly the premier laboratory of its kind in the world. Numerous new record-setting magnet systems have been developed and installed, including the 45 T Hybrid and the 60 T Long-Pulse magnet at LANL. Users have access to no less than nine facilities that are the highest performing systems of their kind in the world. The users program is in high gear: There has been a 60 percent increase in users during the last five years. Over 25 percent of NHMFL users come from outside the United States, suggesting that they are bypassing facilities closer to them to access the highest magnetic fields in the world.

As in the beginning with Drs. Moulton and Hooper, the NHMFL's greatest strength lies in its people. The Science Program has been led by Drs. Robert Schrieffer and Lev Gor'kov. The Magnet Science and Technology Program was led for many years by the world's foremost magnet engineer, Dr. Hans Schneider-Muntau, followed by Dr. Steve Van Sciver in 1997. The importance of amassed human capital is perhaps no where more evident than in the MS&T program, where groups or teams or projects have been formed, re-formed, and re-formed again to meet the changing needs of users and to respond to new magnet engineering and materials opportunities.

Certainly, many, many other people could be recognized here, but we would need the entire newsletter to do it! Suffice it to say, however, that the NHMFL has become the finest magnet laboratory in the world because of the talents, intelligence, diversity, and combined efforts of hundreds of people. I know that this dedicated group of professionals awaits the National Science Board's funding decision in October and looks forward to building on this strong foundation during the next decade.

Jack E. Crow

From the Chief Scientist's Desk



In this report, the group of L. W. Engel and co-workers discuss surprising data on the magnetic field dependence of the microwave absorption of the two dimensional gas. The particular geometry studied was that of a square array of antidots (holes) in the uniform system. Surprisingly they find that the microwave electrical conductivity increases with magnetic field as opposed to that expected for the composite particles that are the carriers for this system. A possible interpretation is suggested in which a second phase coexists with the conventional composite particle liquid. This new phase, which forms at low temperature, might be localized near the antidots where the electron density is low. It would become more mobile as the magnetic field is increased. This unique behavior suggests that other studies be carried out to explore this new phase, which may be a Wigner crystal in which the carriers are localized at low density.

High Magnetic Field Microwave Response of 2D Electrons in an Antidot Array

P. D. Ye, *NHMFL and Princeton University, Department of Electrical Engineering*
L. W. Engel, *NHMFL*
D. C. Tsui, *Princeton University, Department of Electrical Engineering*
J. A. Simmons, *Sandia National Laboratories*
J. R. Wendt, *Sandia National Laboratories*
G. A. Vawter, *Sandia National Laboratories*
J. R. Reno, *Sandia National Laboratories*

We present data on 2DES patterned with an "antidot" lattice. An antidot is a small region of the 2DES from which the electrons are excluded. Using electron beam lithography and reactive ion etching, our Sandia collaborators patterned samples with arrays of tiny holes that produce the antidots in the 2DES, which resides about 0.1 µm below the top surface of the $GaAs/Al_xGa_{1-x}As$ wafer. Micrographs of the holes appear in Figure 1b. Our motivation for looking at the microwave response of 2DES in an antidot lattice was to investigate the dynamics of "composite fermions" (CF's),[1] exotic particles that can be thought of as electrons bound up with an even number of flux quanta, and that have readily-interpreted[2,3] features in dc transport in antidot lattice potentials.

Microwaves are applied to the 2D electron system using a broadband transmission line arrangement,[4] as shown in Figure 1. The transmission line consists of three thin metal film conductors that are patterned onto the top of the wafer, and which couple capacitively to the 2DES just beneath. The center conductor is driven with respect to two grounded side planes, so that the in-plane microwave electric field is well-confined to the slots between center conductor and side planes. In the figure, the electric field would point vertically up or down, transverse to the microwave propagation direction. When present, the antidot lattice is fabricated within the slots, where it is exposed to the microwave field. By means of high quality, stable coaxial cables, microwave signals are sent from

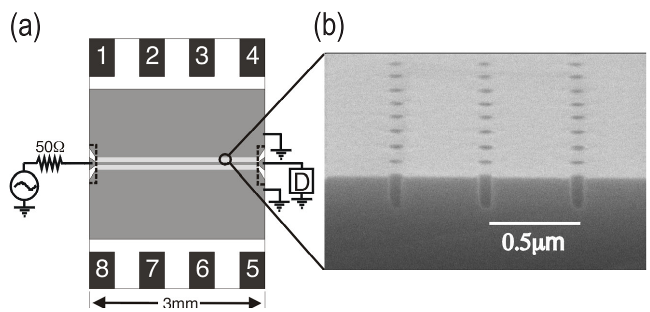


Figure 1. Figure 1 (a). Schematic of a sample connected to the measuring circuit. "D" is a room-temperature, 50 Ω detector. The numbered pads at the edge of the sample are ohmic contacts to the 2D electron system, which is etched away in the small regions enclosed by the dotted lines. Dark gray shading is metal film deposited onto the sample surface; lighter shading in the slots represents the antidot lattice, shown enlarged in (b).

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a room-temperature source, through the line, then back up to a room-temperature receiver. Re(σ_{xx}), the real part of the microwave-frequency diagonal conductivity of the 2DES, is calculated from the attenuation of the transmission line.

Figure 2 shows traces Re(σ_{xx}) vs. magnetic field B, for several frequencies (f), for a sample with a 0.5 m square antidot lattice. At the lowest f of 0.1 GHz, the trace shows features that are well-known from dc transport, including several dips in Re(σ_{xx}) coming from the fractional quantum Hall effect (FQHE). Around ν=1/2 (B=8.5 T), there is a small peak that is known to be associated with the scattering of composite fermions in the potential of the antidots, and is marked "CF" in the figure. In lower-disorder samples, this feature can be larger, and can split into two peaks, corresponding to composite-fermion cyclotron orbits encircling antidots.[2,3]

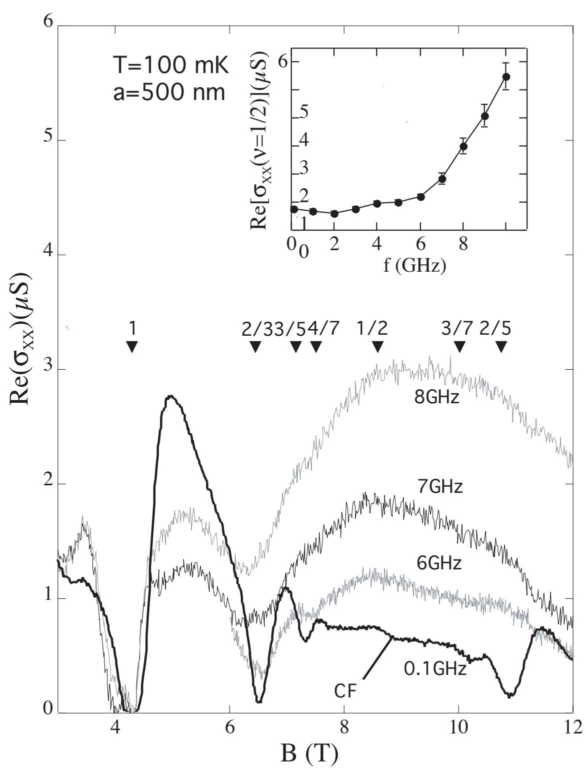

Figure 2. Measured microwave conductivity, Re(σ_{xx}) plotted against magnetic field, B, for a sample patterned with an antidot lattice constant a=500 nm. Solid triangles mark the Landau level filling factors, ν. The inset shows Re(σ_{xx}) at ν=1/2, vs. the microwave frequency.

What is surprising is that the frequency (f) dependence is revealed in the successive higher-f traces, which show Re(σ_{xx}) increasing dramatically with f over a broad region of B, extending down to ν~1. In the high f traces, the elevated Re(σ_{xx}) shows a broad peak at B~9.5 T, just above where ν=1/2. In measurements of samples from the same wafer, but lacking antidots, the strong increase of Re(σ_{xx}) with f is absent, so the effect is clearly due to the antidots. The inset to the graph shows Re(σ_{xx}) vs. f at ν=1/2. The increasing Re(σ_{xx}) vs. f, and the broad maximum in Re(σ_{xx}) vs. B disappear gradually as the temperature is increased; Re(σ_{xx}) on the broad peak for 8 GHz traces is roughly halved at 200 mK, and the peak is unobservable at 600 mK.

At this point we can only speculate about the origin of the increasing Re(σ_{xx}) vs. f. The CF picture that motivated the work would not seem to be the natural one for explaining the effect, since the anomalous f dependence extends over such a wide range of B. The observed f dependence is contrary to expectation for ordinary metallic systems, whose real conductivity should decrease monotonically with f, at least roughly according to the Drude model. In insulators, hopping conductivity, modeled for 2DES in high B in Reference 5, increases with f, but the 2DES patterned with antidots is not an insulator in the magnetic field region of interest, since the dc conductivity is not decreasing with decreasing temperature.

The data suggest the anomalous response is due to a state that forms at low temperature but which has little effect on the low-f or dc conductivity, which as we have seen is explicable in terms of the FQHE and CF's. Hence the phase would coexist with the FQH liquids and CF metal, most likely in the immediate neighborhood of the antidots. This coexisting state could be associated with the edges of the antidots, or with localization or Wigner crystallization[6] in regions of reduced charge density in the antidots.

1 B. I. Halperin, P.A. Lee, and N. Read, Physical Review B 47, 7312 (1993).

2 W. Kang, H.L. Stormer, L.N. Pfeiffer, K.W. Baldwin, and K.W. West, Phys. Rev. Lett. 71, 3850 (1993).

3 J. H. Smet, D. Weiss, K. von Klitzing, P. T. Coleridge, Z. W. Wasilewski, R. Bergmann, H Schweizer, and A. Scherer, Phys. Rev. B 56, 3598 (1997).

4 L. W. Engel, D. Shahar, Ç Kurdak, and D. C. Tsui in Proceedings of Physical Phenomena in High Magnetic Fields II, edited by Z. Fisk, L. Gor'kov, D. Meltzer and J. R. Schrieffer, (World Scientific, Singapore, 1996) 23.
5 D. G. Polyakov and B. I. Shklovskii, Phys. Rev. B 48, 11167 (1993).
6 C.-C. Li, J. Yoon, L. W. Engel, D. Shahar, D. C. Tsui, M. Shayegan, Phys. Rev. B 61, 10905 (2000).

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Engineering. All three have unique resources for the development of new equipment and systems for electrical power applications and for training the next generation of electrical power system engineers. The center is dedicated to developing a multidisciplinary research program with a strong partnership between government, industry, and the academic research community. "Recent developments in superconductivity, magnetics, solid state power switching and control give power system engineering a whole new range of options to work with," said James Ferner, interim director of CAPS. "We are on the edge of a revolution in electrical power engineering."

The Navy program will be focused on system simulation and modeling, supported by experimental verification to develop and evaluate advanced power systems for new and retrofit ship programs. A systems approach is essential to achieving the Navy's objectives of reducing life-cycle operation costs of surface ships by reducing manpower while improving fleet combat effectiveness, reliability, and survivability. Manpower currently accounts for the majority of total ship life-cycle costs with a major portion of that dedicated to mechanical and electrical systems. Electric ships are expected to cut manpower costs in half, through automation and replacement of high maintenance steam, hydraulic, and compressed air systems with new electrical technologies.

"This is a major transition that will build a Navy of the next century which is fundamentally stronger than the Navy of the past and better adapted to seize the opportunities of the future," said Secretary of the Navy Richard Danzig. "The architecture of our ships will change dramatically as will the conditions under which our sailors operate and the way we go to sea." He went on to say, "Electric drive will change the character and power of our forces in revolutionary ways."

While research and development of next-generation ship propulsion will be a major focus at the FSU Center for Advanced Power Systems, the Navy and FSU scientists expect equipment and systems developed at the center to have broader applications in aerospace, commercial industry, and electric utilities.

The CAPS program incorporates a direct industry involvement via end users and component manufacturers. It provides an ideal research environment for encouraging the Navy's "dual use" strategy, which couples military needs with civilian market developments to share development and manufacturing costs.

"Our significant multi-million dollar investment in the FSU Center for Advanced Power Systems recognizes the contribution that Florida State can make to this vital Navy initiative," said Adm. Jay Cohen, director of ONR.

"We see this opportunity to work closely with the Navy, other federal agencies, and the private sector as a unique collaboration and one that will serve all participants well," said Raymond Bye, vice president for research at FSU. "The creation of this center at FSU will move the vision for an all-electric Navy to the next level."

The FSU Center for Advanced Power Systems comprises scientists at the Florida State University, the National High Magnetic Field Laboratory in Tallahassee, FSU/FAMU College of Engineering, and other academic and industrial participants.

For further information on CAPS, contact Jim Ferner, CAPS interim director (850-644-9630, fax 850-644-9462, ferner@magnet.fsu.edu).

PROFESSOR DWIGHT ADAMS continued from page 1

"The importance of Dr. Adams' invention to low-temperature research is clear," said Neil Sullivan, NHMFL Co-Principal Investigator at UF. "Temperature is one of the most fundamental of the thermodynamic parameters needed to specify the state of all systems, small and large. Without a careful and precise method of measuring the temperature on which we can all agree, scientific progress cannot be made. Dwight's contribution gives the low temperature physicist just that reliability and precision needed for exploring phenomena at the lowest possible temperatures. In many ways it is the 'sextant' of the low temperature physicist."

UF Physics Professor Dwight Adams (left) records and compares data with Associate Research Scientist Jian-sheng Xia on an ultra-low temperature experiment in UF's Microkelvin Laboratory.

As the world's most reliable thermometer for cold temperatures, the new scale using the Straty-Adams gauge will extend almost a factor of 1000 below the present one, to temperatures close to absolute zero, 0.0009 K. While other materials freeze solid when subjected to ultra-cold temperatures (below 1 kelvin), helium does not freeze even at absolute zero unless an external pressure is applied. The pressure required to freeze a mixture of solid and liquid of the rare isotope helium-3 depends strongly on the temperature. The Straty-Adams gauge measures pressure, which is a reliable reproducible function of temperature. The gauge is highly sensitive to pressure changes in the liquid/solid mixture and these pressure changes can be calibrated in a fundamental way to the temperature of the mixture.

To operate, the device is positioned in situ inside the inner chamber of a cryostat at the point where the temperature is to be determined. As the temperature drops and the isotope changes states, the corresponding changes in the melting pressure causes the diaphragm in the gauge to move. Although very slight, less than 0.02 mm (one-thousandth of an inch), the motion is translated into temperature change by an equation for P(T).

Straty-Adams gauges are used routinely by scientists involved in ultra-low temperature research. The 1996 Nobel Prize in physics was bestowed upon researchers who employed the gauge in their study of helium-3 properties at low temperatures. David Lee and Robert Richardson of Cornell and Douglass Osheroff of Stanford chilled a helium-3 sample to about 2 mK, and discovered its transformation into a superfluid. Superfluidity is a special liquid state of matter that can flow without viscosity.

Recent significant interest in ultra-low temperature research has driven the need for a more accurate measuring standard. Until the last twenty years, ultra-low temperatures had been out of reach for most laboratories. When advances in refrigeration lowered temperatures to 0.01 K, ultra-low temperatures became commercially available. The method, called melting pressure thermometry or MPT, by which the Straty-Adams gauge uses helium as an ultra-cold thermometer produces a validation problem for researchers, however, because the precise relationship between a given pressure of mixture and the corresponding temperature P (T) needs to be known.

While MPT and the Straty-Adams gauge have been in widespread use internationally for 30 years, only within the last decade have university and standards laboratories made the measurements needed to validate the scale.

These measurements, made at National Institutes of Standards, Physikalisch-Technische Bundesanstalt, Berlin, and in Adams' lab at UF have established a mathematical equation that specifies the relationship between pressure and temperature and sets values of fixed points.

The world's current official temperature scale, the International Temperature Scale of 1990 (ITS-90), has a lower limit of 0.65 K. The new scale will drop to 0.0009 K once MPT using the Straty-Adams gauge is adopted in September. With its labeling as the world standard, scientists around the world will be able to measure and compare their results with a much greater degree of accuracy.

Conference & Workshop Activity

Electrospray Ionization FT-ICR Mass Spectrometry Tutorial Workshop

November 8-10, 2000
NHMFL, Tallahassee, Florida

The NSF National High-Field FT-ICR MS Facility will offer a hands-on tutorial workshop this fall. The program will consist of five half-day sessions, divided between oral presentations and hands-on sessions on electrospray FT-ICR MS.

This workshop is designed to introduce the participant to the principles, instrumentation, hands-on operation, and selected applications of this technique. More advanced topics will be included as time permits.

The program will be presented by Alan Marshall (overview and principles), Christopher Hendrickson (FT-ICR instrumentation) and Mark Emmett (electrospray and applications). Provided reference materials will include review articles and handouts of overheads. A unique feature of the program will be hands-on access (groups of no more than five participants) to gain familiarity with sample preparation/introduction and instrument operation/optimization. Instrument operation will be presented in general terms, and will not be limited to any particular vendor.

The fee for this workshop will be $1,200.00; enrollment will be very limited to ensure individual attention during the hands-on sessions. To register or for further information, contact Alan Marshall, director of the NHMFL ICR Program, 850-644-0529, fax 850-644-1366, *marshall@magnet.fsu.edu.*

US-Japan Joint Seminar on Innovative Measurement Techniques in Cryogenics

December 3-6, 2000
NHMFL, Tallahassee, Florida

Considerable progress has been made in this field over recent years, some of which has been driven by applications such as superconducting magnet systems and space-based technology. In addition, other major applications and opportunities exist in the development of refrigeration, particularly small-scale cryocoolers. This three-day seminar will bring together researchers involved in making cryogenic measurements and developing instrumentation to discuss new techniques, devices, and their use in measurements and applications.

The small workshop environment, with approximately 30 attendees, is expected to provide a very effective forum for focused exchange. Some of the contributions will be of a tutorial nature and given by world leaders in the field. Shorter contributions on more narrowly defined topics will be sought from junior scientists and graduate students.

The NHMFL, NSF International Programs Division, and the Japanese government are co-sponsoring this event that will be held at the NHMFL in Tallahassee. For further information, contact Steve Van Sciver, director of NHMFL

CONFERENCE & WORKSHOP ACTIVITY continued on page 8 ▶

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Magnet Science and Technology Program, 850-644-0998, fax 850-644-0867, *vnsciver@magnet.fsu.edu.*

Third North American FT-ICR Conference

March 22-24, 2001
Austin, Texas

The NHMFL ICR Program initiated this biennial conference in Tallahassee in 1997. Interest was extremely high, so a second meeting was held two years later in San Diego and 128 people attended. Community demand remains high, and planning continues toward the Third North American FT-ICR conference in 2001. For updated information, contact Alan Marshall, program director, 850-644-0529, fax 850-644-1366, *marshall@magnet.fsu.edu.*

Physical Phenomena at High Magnetic Fields (PPHMF-IV)

October 19-25, 2001
Santa Fe, New Mexico
Hotel Headquarters: Hilton of Santa Fe

This major international conference was initiated by the NHMFL in 1991 and is held every three years. After three meetings in Tallahassee, PPHMF-IV is moving to New Mexico! For updated information, see the conference web site: *http://www.lanl.gov/mst/nhmfl/PPHMF4/.*

Applied Superconductivity Conference (ASC04)

October 4-8, 2004
Site: Jacksonville, Florida

This major conference is held every two years. In September 2000, ASC00 will be held in Virginia Beach, Virginia; ASC02 will be in Houston, Texas, in August; and in October 2004 ASC04 comes to Florida. This important international meeting typically attracts over 1,800 participants. For information, contact Conference Chair Justin Schwartz, project leader in NHMFL's Magnet Science & Technology program, 850-644-0874, fax 850-644-0867; *schwartz@magnet.fsu.edu.*

Center for Advanced Power Systems (CAPS)

July 25-26, 2000
Tallahassee, Florida

On July 25 and 26, seventy representatives from industry, the U.S. Navy, academia, and government laboratories attended the CAPS Naval Power Systems Issues workshop at the NHMFL in Tallahassee. The workshop established significant collaborative interactions and generated input from the participants that will assist CAPS in developing its research program in support of the Navy's all-electric ship and related dual-use technologies. (See page 1 for more information on CAPS.)

Presentations and focused panel discussions at the workshop prompted an exceptional dialogue on dual-use strategies, economic drivers, technology insertion, simulations, and new equipment applications. One of the objectives of CAPS will be to provide technical leadership at the power engineering systems level and to bring ship builders, equipment vendors, and the Navy together on the same development path.

At a press conference on Tuesday morning, Raymond Bye, FSU vice president for research, announced a $10.9 million, three-year contract with the U.S. Office of Naval Research for R&D of the Navy's next-generation, all-electric ship. Adm. Jay Cohen, director of the Office of Naval Research, explained the Navy's historic decision to move to the all-electric ship and the implications of such a move—enhanced wartime survivability, reduction of manpower, improved living conditions, applications to industry, etc. He also commended FSU and the NHMFL for seeing the opportunities of new magnet-related materials and control technologies and for "seizing the moment" to drive new applications by working with the Navy and industry. Other speakers included FSU President Talbot "Sandy" D'Alemberte; James Ferner, CAPS interim director and former NHMFL Chief Administrative Officer; and Al Tucker, program officer at ONR.

For more information on CAPS, contact Jim Ferner, 850-644-9630, ferner@magnet.fsu.edu.

French Senator Visits the NHMFL at Los Alamos

Alex Lacerda, *Director Pulsed Field User Programs*

Since my Ph.D. thesis in France in 1990, I have maintained very good contacts with many French scientists. It has been my pleasure to host French students and scientists from time to time during my ten years here at LANL. During 1994, I started to have more contact with the French Consulate in Santa Fe, New Mexico. The Honorable French Consul of New Mexico Gilles Milinaire visited the NHMFL for the first time during the summer of 1994.

French delegation outside NHMFL facilities at Los Alamos National Laboratory. French Consul of New Mexico Gilles Milinaire (center), Alex Lacerda and Greg Boebinger (far right behind fence).

On June 7th the NHMFL, Los Alamos Facility was honored to host a visit by the Honorable French Senator for Education, Monique Cerisier-Ben Guiga. Madame Cerisier-Ben Guiga also serves as a member of the French Ministry of Labor and Foreign Affairs. Madame Cerisier-Ben Guiga was accompanied by Claude Girault (French Representative for the West of the United States) and Gilles Milinaire (Honorary French Consul for New Mexico). After a short presentation on recent scientific accomplishments and collaborations at the laboratory, NHMFL Director of Pulsed Field Facilities Greg Boebinger and I gave them a tour of the facilities. After the tour the French team had a chance to meet with French scientists at LANL.

The visit went very well, and I have since received several messages from the delegation expressing how impressed they were with our installations. The following is an example (translated from French):

Dear Dr. Boebinger and Dr. Lacerda,

We would like to thank you for your time to host our visit and to clearly describe the operation of the High Magnetic Field Facility. The Senator and myself were very impressed by the Laboratory, the scientific accomplishments and the impressive infrastructure. We have also discovered the importance of high magnetic fields not only in basic science but also in technology and medicine.

We also appreciated the chance to talk to young French scientists at Los Alamos; with no doubt this already represents a good scientific collaboration between France and the United States.

Sincerely,

Senator Monique Cerisier-Ben Guiga
French Representative Claude Girault
French Consul for New Mexico Gilles Milinaire

Optical Microscopy: New Academic and Industrial Partners

The optical microscopy program at the NHMFL is maturing into a sophisticated research and educational resource that is attracting some new partners in both industry and academia. In addition to ongoing research in magneto-optical imaging with Dr. Justin Schwartz' group, we are launching a new effort to investigate the properties of living cells in the presence of magnetic fields using cells grown in culture and stained with fluorescent dyes. This research will be sponsored, in part, by the Nikon Instrument Group, headquartered in Melville New

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York. Nikon will provide us with an inverted tissue culture microscope equipped with a mercury vapor illuminator and fluorescence filters in order to study the cells in culture.

Other projects with Nikon include construction of a technical support web site that will provide microscopists with the latest information about various aspects of microscopy and photomicrography. This web site will contain an open discussion forum that will be monitored both by our staff and the scientists at Nikon to help answer questions from investigators around the world. In addition, a microscopy knowledge database is being constructed to offer "bite-sized" pieces of detailed information about specific areas of microscopy. In our experience, this type of presentation will be the optimum method of disseminating knowledge to the research community.

Recently, Nikon held its 26th Annual Small World Photomicrograph contest that attracts entries from scientists around the globe. During the past 25 years, this contest has consistently attracted about 750 entries from over 300 scientists each year. This year, however, the number of entries was only 250, because of the decline in the use of 35-millimeter film for recording photomicrographs. Both Nikon and Olympus report that sales of film cameras are yielding in a significant manner to digital imaging devices based on CCD technology, and that the number of film cameras ordered has dropped to only about 10 percent of the total cameras sold (both film and digital). Taking this into consideration, we are collaborating with Nikon to move the Small World contest into the digital age by offering registration and entry submission over the web. This new entry format will be in place for the 2001 contest and will be housed on the Nikon microscopy technical support web site.

Not to be outdone, Olympus (also headquartered in Melville, New York) has offered to expand their partnership with our program. We have met with Olympus officials to mold a new incentive that includes expansion of the Molecular Expressions Microscopy Primer, probably the premier microscopy educational resource currently available on the web. In addition, we will be collaborating with Olympus to develop a new type of microscope that dispenses with eyepieces in favor of direct digital imaging using CMOS and/or CCD integrated circuits. Under this format, the microscope digital imaging system will be connected directly into a computer so that scientists can visualize specimens on the monitor and record either single digital images, time-lapse sequences or full-motion video, yielding a greater latitude in photomicrograph that has been previously possible. We have also agreed to examine new digital cameras and microscopes manufactured by Olympus' competitors with the purpose of comparing performance to current Olympus offerings. The company has also expressed an interest in offering premium items such as mouse pads, coffee mugs, and T-shirts based on our photomicrographs taken using Olympus microscopes.

In the academic arena, we have been joined in our educational efforts by Dr. Kenneth R. Spring of the National Heart, Lung, and Blood Institute, a division of the National Institutes of Health. Dr. Spring will be contributing as a co-author to the Microscopy Primer from his wealth of research and review material on digital imaging using fluorescence microscopy in cell biology. The first product of this collaboration is an article entitled: "Electronic Imaging Detectors in Fluorescence Microscopy" that has been posted on the web site. We will continue to draw from Dr. Spring's many resources to help make the Molecular Expressions web site the premier home for optical microscopy on the web.

Our other new academic partner is Dr. Robert Hoffman, who is known for his invention of the optical microscopy contrast-enhancing technique entitled Hoffman Modulation Contrast. Dr. Hoffman has already co-authored a section of the Microscopy Primer on contrast techniques and will be involved in future sections dealing with phase contrast and differential interference contrast.

The Cerro Grande Fire at Los Alamos—Lives Turned Upside Down

Thankfully, the forest fires that occurred around Los Alamos National Laboratory in May remain extinguished —even as 85 other major fires blaze out of control in other western states. In the aftermath of the Los Alamos fire, we learned that while everyone was safe, NHMFL colleagues had suffered the whole range of losses, from minor to catastrophic. To assist with the recovery, the NHMFL family collected $5,000, and we were pleased to learn that at the end of July, President Clinton signed a compensation bill that authorizes $455 million for fire victims and $138 million for damages to the laboratory complex.

While the memories of May were still fresh, *Lou Miller*, the key support person for the NHMFL team at LANL, recorded what it was like for our colleagues to endure such a frightening experience. We thought readers of NHMFL Reports and friends around the world who have visited LANL would like to read it as well.

As we left work on Friday, May 5, a plume of smoke was rising straight up directly in front of us at the intersection of our road and Pajarito. The wind was ferocious. When we returned to work on Monday, May 22, the fire had moved 90º to the right and about 10º to the left and had crossed the road to the canyon bottoms. Devastation was not confined to the mountains; lives had also been devastated.

I had planned to come back up to Los Alamos on Saturday, May 6, for the annual spring Arts and Crafts show and jokingly commented to the friend coming with me that we might have to turn around without seeing our favorite vendor. But when we arrived about 9 AM on Saturday it was clear and there was no sign of smoke. When we left about noon the wind was just coming up. I finished my weekend chores in Santa Fe and as I returned home the whole northwestern sky was one very large low-lying cloud of smoke. On the 6 o'clock news the announcement was made that the fire had gotten out of control but they expected it to be controlled within 24 hours. By Sunday morning, the cloud was smaller,

FIRE AT LOS ALAMOS continued on page 12 ▶

FIRE AT LOS ALAMOS continued from page 11

by Sunday afternoon it was again stretched across the *horizon. It was with mixed feelings that I heard that the lab would be closed on Monday, but we could expect to return to work on Tuesday…Maybe Wednesday, oops not Wednesday because Los Alamos was being evacuated. Wednesday night a press conference was scheduled for 10 PM…11 …12. At 1AM I fell asleep. About 1:30 White Rock was evacuated. This fire had become a monster.*

Those of us not in Los Alamos could only sit, glued to our television sets and watch the graphic pictures in horror. Where were our friends and colleagues? How could we get in touch with them? I had planned a trip to California leaving Friday returning on Monday. My children said come early Mom. I could not leave early, my world was in too much danger and I couldn't desert. Knew I could not do a single thing but I could not leave a burning mountain.

Those evacuated from Los Alamos could only sit, glued to the television set in the hotel lobby; in the home of family, friends or complete strangers who had taken them in; in a shelter; and watch in horror. The pictures were terrifyingly graphic. They had to know if their home was in the direct path of this monster; or wonder how long before the wind changed and their home would be its direct path. It was five long days before they would be allowed to return home—or what was left of it.

Greg Boebinger did a great job of keeping in touch with everyone. Dwight Rickel evacuated to a friend in Santa Fe. Dwight and Linda decided to go see their kids in Seattle after seeing their lot go up in blazes. Thank goodness they had not started construction. Dwight has decided to use one of the burned trees on the lot as a beam in the new home they are planning to build there. Heinrich Boenig and his family and dogs went to Sunrise Springs in Santa Fe. Alex Lacerda was desperately trying to get back to the states from a conference in Brazil. Andrea and Hugo were in a hotel in Santa Fe, frightened, but did not wish to stay with those who offered homes. All we could do was keep in touch with Andrea and try to calm her fears. Hal and Judy DeHaven went to Judy's mother in Santa Fe and watched the fire destroy their home. This was the second home they have lost to fire. Fedor Balakirev was with Greg working on a paper when the notice came to evacuate. He took his 10-year-old daughter and 9-month-old son, stopped in Santa Fe, and picked up Luda from her workplace and fled to Albuquerque. They had only the clothes on their backs. Thank goodness, their home only had smoke damage. When they arrived in Albuquerque a friend took Fedor down to one of the local TV stations where collections were being made for the fire victims. After much discussion it was finally made clear that Fedor was a fire victim. They gave him diapers for the baby. Fedor and family decided that they really needed to get away from the fire so they visited friends in San Diego. Chuck and Angela Mielke and the boys, ages 2 and 4, evacuated to Neil Harrison's in Santa Fe. Neil said it certainly was quiet when they returned home. Marcus Bennett opted not to stay with Scott Crooker but instead, to pay $25 a night for a few nights in the Inn of the Anasazi, one of Santa Fe's premier hotels. Greg and Karen and their kids camped with Al Migliori and his family. Marcelo Jaime and his family purchased a new home in Los Alamos in January. Friends moved into the apartment the Jaime's had moved out of. The apartment was totally destroyed. Marcelo and his family spent the time at Santa Fe High School evacuation center. Andy Christianson threw all of his personal possessions in his car, did not have room for his textbooks. His apartment was destroyed. Mike Pacheco and John Rogers went to family in Santa Fe. Joe Schillig left White Rock and went to Colorado. Adam Kuipers family home was one of the few standing on the street where the DeHavens lived. The county condemned it. No one knew where Florin Munteanu was. When we returned to work he told us he took advantage of the time for a nice vacation.

Those of us who commute did not know what to expect when we returned to work on Monday, May 22. Jon Betts and I came up the hill through White Rock and looking up at the burned area it looked as though a large cloud was covering the sun over a good part of the mountain. That area was where the fire had burned. The pattern is strange. There is an area of green both above and below the burned area. You can see roads and trails you did not know were up there. I expected to see devastation all up the hill from White Rock but it was not until we reached the top of the mesa that we begin to see burned areas on the side of the road. Trees brown on one side, still green on the other but standing. Grassy areas burned where *fire breaks had been set. Some of these very close to buildings. Our immediate area had no damage. There are spots where it came up the canyon walls close to the top of our mesa. We had to walk fire patrol for several days because the canyons on both sides of our mesa still had hot spots. We reported two fires. We are still not allowed on the recreational paths down in the canyons.*

A tour of the burned out area, however, was very different. Blocks of homes were literally twisted masses of debris. Chimneys standing in the middle of black masses. Cars were just shells with melted tires, or rims where tires had completely melted away. Stairwells led to nothing. Wrought iron had not melted but barbecue pits had blown up. One aluminum carport was a twisted mass, another nearby not even scorched. A round wrought iron wood holder with a heavy black syrup kettle hanging from it swinging in the breeze. Pine trees and houses burned to the ground, green grass and shade trees beautifully leafed out in what was the front yard. Foundations surrounding what looked like a fire pit. I saw a man who could easily play tackle for the Broncos get out his car and break down in tears. Hal DeHaven said he was alright sifting through the debris and ashes of what was left of his home for the last 24 years until he looked up and saw his granddaughters red plastic swing gently swinging from the branch of a burned out ponderosa pine. He lost it. But humor abounds. Signs saying "Fire Sale." Judy DeHaven's boss gave her a sign reading "Caution: Ashes slippery when wet." A large sign on a home that did not burn read: " Our baby says thank you for saving our home."

Having lived on the gulf coast for several years and seen two of the most devastating hurricanes in this century, I have seen the devastation that Mother Nature can unleash. But this fire was different. The feeling that this was a disaster waiting to happen has been in the back of many minds. Over the past several years and particularly this past winter the dryness was heartbreaking. Los Alamos received less snow than Santa Fe, a very unusual occurrence. The ski basin had no snow all year. The mountains that should have been covered in white were green all year. Driving up you could almost feel the dryness. You felt that if one spark of any kind touched the grass and trees they would explode. Well, they did. And all we could do was watch, wait, and pray. The damage was unthinkable but it could easily have been much worse. The potential was there for everything between the mountains and the Rio Grande to go up in smoke. The amazing thing was the minimal damage.

There are not many ways off this mesa: two highways and forest roads and they all converge at the Y. The Jemez road was blocked because the fire was in that direction. Los Alamos—18,000 people—was evacuated in three hours. It took a little longer for White Rock because all of the side streets converge at NM 501. (I have spent six hours getting off the hill during a bad snowstorm.) Enough credit cannot be given to those in charge of the evacuation, to the firefighters, and yes, to both the U.S. Forest Service and the U.S. Park Service. The emergency trial runs that are held regularly paid off. We hope we never have to test them again. ■

FSU & UF Faculty Promotions

Congratulations to ten NHMFL colleagues who have been promoted recently:

Florida State University

Mark D. Bird, *to Scholar/Scientist*
Scott T. Hannahs, *to Research Associate*
Eric Palm, *to Research Associate*
Dragana Popovic, *to Associate Scholar/Scientist*
Arneil P. Reyes, *to Associate Scholar/Scientist*
Stanley W. Tozer, *to Associate Scholar/Scientist*
Yong-Jie Wang, *to Associate in Research*

University of Florida

Clifford Russell Bowers, *to Associate Professor, Chemistry*
Daniel R. Talham, *to Professor, Chemistry*
David B. Tanner, *to Distinguished Professor, Physics*

■

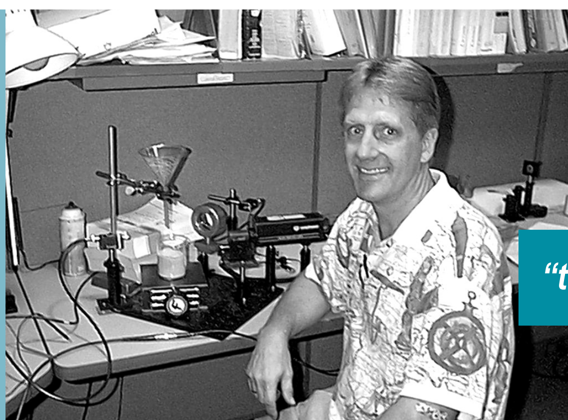
Summer Education Activities: A Potpourri of Pictures

The NHMFL Center for Integrating Research and Learning again hosted talented teachers and undergraduates in the Research Experiences for Teachers program and Research Experiences for Undergraduates summer internship program. An essential part of both programs is combining research with presentation skills and events that encourage communication and collaboration among groups. In addition to this sharing of ideas, both groups went to the University of Florida, Gainesville, NHMFL site to meet and collaborate with their counterparts there.

"My vision of science has been enhanced through the work I did with my mentor and the sharing of experiences we had with other groups."

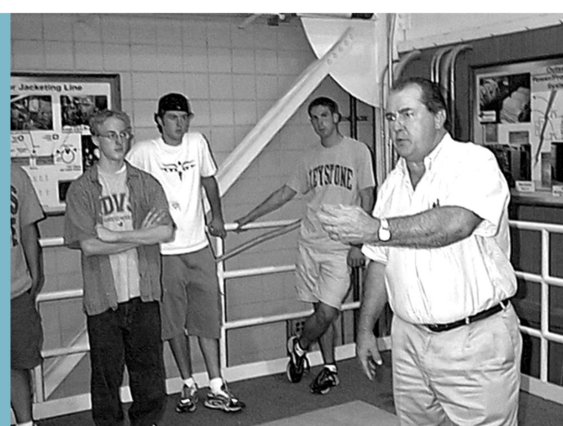
Sixteen participating teachers presented their work in a public showcase of materials they created to translate their research experiences into classroom activities. The showcase on Friday, July 21st, combined with written reports, gave teachers a chance to articulate what they had learned about the process of science, magnets and related content material, and science education. One elementary teacher said, "My vision of science has been enhanced through the work I did with my mentor and the sharing of experiences we had with other groups." Yet another teacher remarked, "Due to my experience here at the NHMFL, I really want to turn my students on to science!"

In addition to these activities, Center educators conducted a week-long Summer Science Institute for Broward County, Florida, teachers. Teachers were presented with a wide variety of activities on magnets, magnetic fields, optics, microscopy, and related concepts. The well-received series of mini-workshops was "the best workshop I've ever had," according to one of the participants. Each of the teachers stated that they would "attend any workshop, any time, any place as long as it was conducted by the Center."



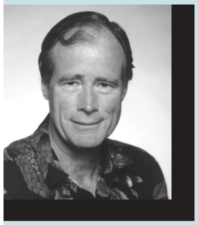
All activities conducted by the Center representing the NHMFL combine science with sound educational underpinnings in addition to technology components. Each facet of the training complements the others to create a well-rounded experience for classroom teachers.

"the best workshop I've ever had"



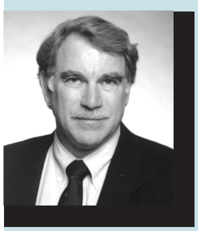
People in the News

Elbio Dagotto, professor of physics and member of the NHMFL Condensed Matter/Theory Group has been invited to be a member of the Board of Editors of the Solid State Communications.

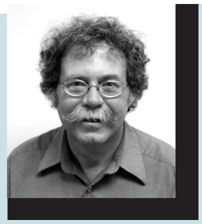


Zachary Fisk, professor of physics with the NHMFL Condensed Matter/ Theory Program, has been named the FSU's Paul A.M. Dirac Professor of Physics. This award was one of 21 given this year as part of the university's new Named Professorship Program. (Alan Marshall was similarly honored; see below). The honor recognizes Dr. Fisk's outstanding contributions and service to science, research, and the university. He is a member of the National Academy of Sciences.

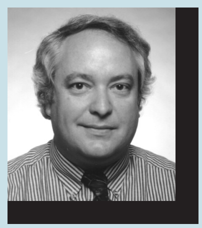
Thilo Fligge received this year's award for the best Ph.D. thesis in Germany, from the DGMS (German Society for Mass Spectrometry). This award was based in part on results obtained at NHMFL's 9.4 electrospray FT-ICR mass spectrometer. The award was presented at the DGMS annual meeting in April, 2000. Dr. Fligge's Ph.D. supervisor is Professor Michael Przybylski at the University of Konstanz.



Alan G. Marshall, professor of chemistry and director of the ICR Program at NHMFL, has been named the FSU Kasha Professor of Chemistry. (Zachary Fisk was similarly honored; see above.) Michael Kasha, FSU Lawton Professor, is one of the university's most distinguished chemists and a member of the National Academy of Sciences (the first in the State of Florida). Dr. Marshall holds several major awards including the Thomson Medal for achievements and service to international mass spectrometry, the New York Society for Applied Spectroscopy Gold Medal (1998), the Maurice F. Hasler Award (1997), and the American Chemical Society Field-Franklin Award for Mass Spectrometry (1995, joint with Melvin Comisarow).

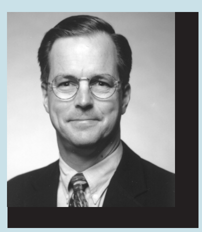


Albert Migliori, a physics researcher with the NHMFL at LANL, has been chosen to replace Zachary Fisk as the head of the NHMFL In-House Research Program. From 1996-1999, the IHRP funded 39 proposals (a total of 102 investigators) in a wide range of science and engineering topics. Many of these proposals focused on developing new techniques that enhance the measurement capabilities at the NHMFL. The 2000 awards are expected to be announced soon. Dr. Migliori was elected to APS fellowship in Spring, 1999, for his work in the development of resonant ultrasound spectroscopy and its application in materials physics and technology.



Timothy Moerland, associate professor of biology and member of NHMFL Nuclear Magnetic Resonance Group has been appointed associate dean of the College of Arts and Sciences. In his new position, Dr. Moerland's focus will be on aiding faculty members and students in reaching their full potential as scholars and researchers.

Adriana Moreo, professor of physics and member of the NHMFL Condensed Matter/Theory Program has been named organizer of a focused session in the APS March meeting 2001, entitled Magneto-resistive Oxides.



Steven W. Van Sciver, FSU engineering professor and director of the NHMFL Magnet Science and Technology Program, has been elected to be a Fellow in the American Society of Mechanical Engineers. Dr. Sciver's main research interests are the design and development of high field superconducting magnet systems, cryogenic systems and cooling for magnets, and experimental measurement of the properties of cryogenic fluids and low temperature materials.

Attention Users

Attention Users

Bruce Brandt
Director, DC Field User Programs

Bruce Brandt
Director, DC Field User Programs

Hybrid Update. The 45 tesla hybrid is really a 45 tesla hybrid, having produced a solid 45.1 T during commissioning tests June 26. We have taken the bold step of scheduling outside users starting October 16. Commissioning tests, fine tuning, and a few local users will keep it busy until then. Researchers interested in using NMR should look at Figures 1 and 2 showing the field distribution and the ^{133}Cs resonance recorded at 40 T (or 39.99901 T as our NMR colleagues would have it). The homogeneity achieved during the mapping was better than 25 ppm/mm DSV (the ratio of the resonance line width at half maximum to the peak frequency divided by the sample diameter). Users whose previous research has demonstrated a clear need for DC fields above 33 T should ask Merry Ann Johnson (*johnson@magnet.fsu.edu*) to send them a Hybrid time request. She can also help them submit a "major user" proposal if they have not already done so.

A couple of small changes to the lab's facilities will make scheduling easier and much more flexible. First, bus bars have been installed in all the cells now in use to allow any combination of power supplies to be used with any magnet. We will no longer have to refuse a user when the magnet is available but the correct pair of power supplies is not. Second, the outer coil of the second 33 T has been replaced with a new, lower resistance version so that it will be available at the full 33 T for users not needing the portable dilution refrigerator.

The User Services Group in Tallahassee has found that soliciting magnet time requests three or four times per year for blocks of three or four months is working well. Those users asking for more than a single week of time are served better than under the old system of filling requests as they arrive. It is also possible to better match the amount of magnet time allowed to the ranking given to the

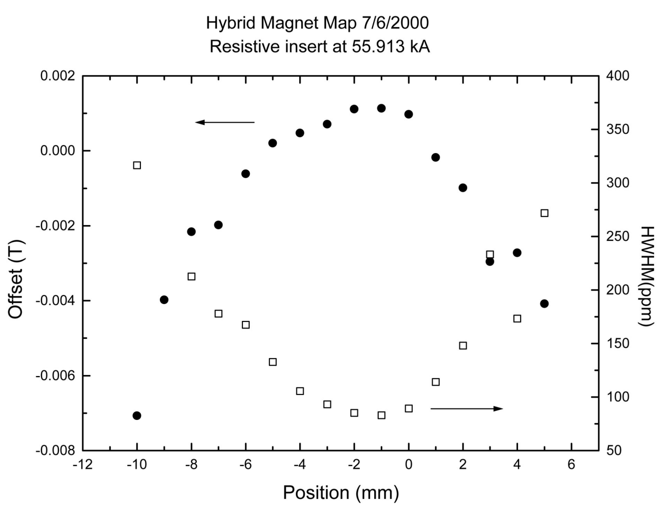


Figure 1. Field Map. The solid circles show the spatial distribution of the magnetic field relative to an arbitrary starting value (left axis). The open squares are a measure of the field homogeneity where the sample was located (right axis). The bottom axis is the distance the sample was moved

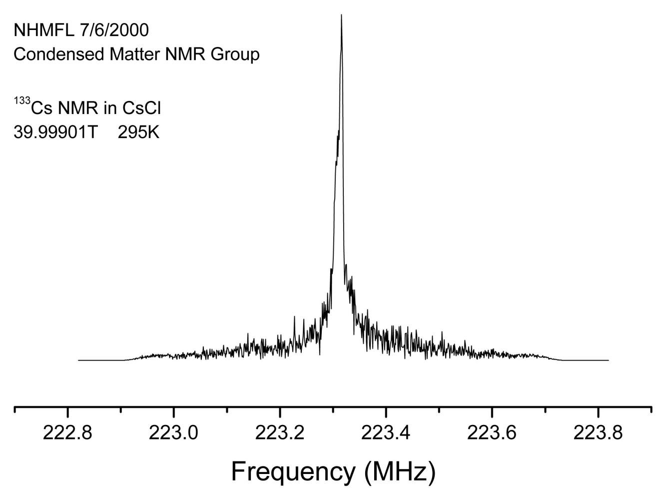


Figure 2. ^{133}Cs NMR signal in CsCl solution at room temperature.

ATTENTION USERS continued on page 18 ►

ATTENTION USERS continued from page 17

research by the Proposal Review Committee. Certain facilities such as the 33 T/portable dilution refrigerator combination and the 45 T Hybrid magnet are fully scheduled at the beginning of the period. Other experiments can be fitted into the available time; and one week each month is still reserved for new users and given to local scientists if still available two weeks ahead. This system obviously requires that most users plan ahead to be sure of getting their magnet time, but pays off in lower travel costs and the ability to adjust teaching schedules and so forth. We have just finished scheduling September 1 through January 12. The deadline for requesting time from January 15 through March 9 will be November 1. The portable dilution refrigerator will not be available during this time; we have not yet decided about the 45 T Hybrid's schedule for early 2001.

Users' Committee

The NHMFL is very grateful to the members of the 1999 and 2000 Users' Committees for their hard work in the preparation of the proposal to the NSF for funding for 2001-2006. Those NHMFL staff who wrote the proposal depended heavily on the Users' Committee members, especially those on the committee in 1999, for suggestions of new instruments and services and for helping the lab and its External Advisory Committee set priorities once all the wish lists had been collated. Several members also took their valuable time to come to Tallahassee to comment on the dry runs of the presentations to be made to the NSF External Review Committee (ERC). The presentations were improved and received good reviews from the ERC. Chuck Agosta, the 1999 Users' Committee chair, also presented the users' views of the lab and its priorities to the ERC. The ERC and NSF took all this input very seriously and incorporated Users' Committee suggestions in their report.

The NHMFL gets excellent advice from its users on how facilities and services can be improved. Some of the advice is informal—comments and suggestions during or after a visit to use the magnets and instruments. Formal advice is provided by the Users' Committee, most of whose twelve members are elected by the user community for three-year rotating terms. The members of the 1999 and 2000 committees are listed below. The committee meets twice a year or as needed to review the status of the facilities and major projects and occasionally asks all users for their input. Any users with any concerns about the facilities and services at the NHMFL may contact the chair or another member of the committee at any time and can be sure that their concerns will be heard.

It is time to begin the process of nominating and electing members to begin serving on the committee in 2001. Any member of the NHMFL user community may volunteer to be nominated or may nominate another person. Members must be working in the United States in some field related to the mission of the NHMFL. U.S. citizenship is not required. Send nominations to *johnson@magnet.fsu.edu* with copies to *lacerda@lanl.gov* and *brandt@magnet.fsu.edu*. An election will be held this fall.

The first group of people officially went off of the Users' Committee 12/31/99 but continued to help with the proposal into 2000.

Bruce McCombe, SUNY at Buffalo, Department of Physics & Astronomy
Chuck Agosta, Clark University, Department of Physics
Jacek Furdyna, University of Notre Dame, Department of Physics
Larry Kevan, University of Houston, Department of Chemistry

The next group of people were on the committee in 1999 and continue to serve in 2000, and in some cases, beyond. The date shown refers to the end of their term.

Stuart Brown, UCLA. Department of Physics, 12/31/2000

Meigan Aronson, University of Michigan, Department of Physics, 12/31/2000
Marty Maley, Los Alamos National Laboratory, 12/31/2000
Jan Musfeldt, SUNY at Binghamton, Department of Chemistry, 12/31/2000
Bill Halperin, Northwestern University, Dept. of Physics & Astronomy, 12/31/2001
Larry Rubin, MIT, 12/31/2001
Michelle Buchanan, Oak Ridge National Laboratory, 12/31/2001
Martin Kushmerick, University of Washington, 12/31/2001
Jim Prestegard, University of Georgia, Complex Carbohydrate Res. Ctr., 12/31/2001
Marion Thurnauer, Argonne National Laboratory Chemistry Division, 12/31/2001

ICR Science Update

The NHMFL ICR group has a couple of new world records in mass spectrometry. First, Drs. Fei He and Christopher Hendrickson have resolved two organic molecules differing in mass by less than the mass of one electron (i.e., less than 0.0005 atomic mass units)!

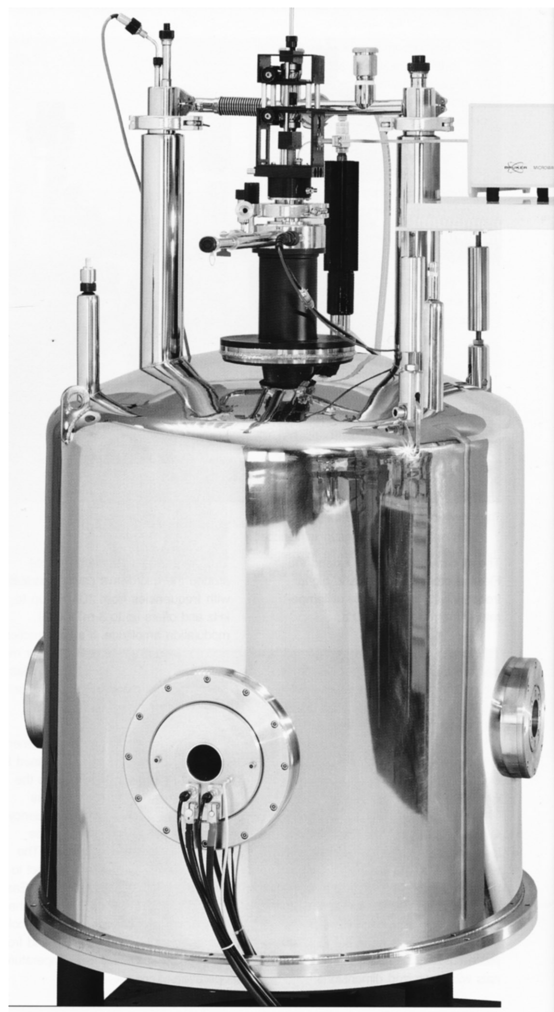
Second, they have identified approximately 5,000 distinct organic compounds directly (i.e., without prior separation) from heavy crude oil. They were able to determine not only the chemical formula (e.g., $C_cH_hN_nO_oS_s$), but also the compound "type" (i.e., number of rings and double bonds), and (for each type) the distribution in number of additional CH_2 groups. That's by far the most complex mixture ever analyzed in a single step.

For further information, contact Alan Marshall, ICR Program Director, 850-644-0529, marshall@magnet.fsu.edu.

Significant New EPR Instrumentation Funded

A consortium of scientists from NHMFL, FSU, FAMU, and UF under the leadership of Professor Peter Fajer has received a $1.1 million grant from the National Science Foundation to acquire a W-band (94 GHz) EPR spectrometer. This state of-the-art spectrometer—the first instrument of its kind in the United States—is capable of high field operation, pulsed (FT) operation, and pulsed Electron Nuclear Double Resonance. The award includes a $333,000 match from the NHMFL, FSU, and UF.

The spectrometer will support a wide range of important research topics and is consistent with the laboratory's commitment to multi- and cross-disciplinary activities. Specifically:



EPR INSTRUMENTATION FUNDED continued on page 20

Biology

Muscle biophysics (Prof. Fajer, NHMFL-FSU Biology and Biophysics). The increased angular resolution, sensitivity to all angles, and ease of interpretation of W-band spectra will be employed to resolve overlapping populations present during contraction and will test the hypothesis that the contraction is brought by rotating head movement of myosin heads. Similar benefits will be derived to describe conformational changes in regulatory proteins responsible for activation of muscle. In particular the group will test the steric-block hypothesis of regulation. The measurements of orientational distribution will be complemented by molecular dynamics using pulsed EPR spectroscopy and multifrequency approach to cover the range of motional modes.

Photosynthesis (Prof. Angerhofer, U. Florida, Chemistry). Fully resolved g-anisotropy of the photosynthetic reaction centers allows for orientationaly selective ENDOR. This in turn will identify hydrogen bonding states of the primary quinone acceptor and in another application explain the triplet quenching which protects oxidation by singlet oxygen. Knowledge of the photosynthetic pathways is limited by the rapidly decaying initial states. High frequency operation combined with transient observation (using pulse EPR) will allow characterization of these initial intermediates.

Metalloproteins (Prof. West, FAMU, Chemistry, Dr. Krzystek, NHMFL). W-band frequencies allow detection of EPR "silent" transitions (at X-band) and thus a full description of electronic structure of FeS clusters in active sites of metalloproteins (rubredoxins, ferredoxins). The coordination geometry and the identity of ligands will be established by pulsed ENDOR experiments. Similar experiments will be performed on di-iron, non-heme metalloproteins known to bind oxygen (hemerythrin). The elucidation of the electronic structure and mode of binding of oxygen is essential in the development of blood substitutes.

Chemistry

(Prof. Hilinski, FSU Chemistry). Photochemical methods will be used to generate, in the cavity of the W-band EPR spectrometer, radicals, radical-ion pairs (from charge-transfer complexes), carbenes, and nitrenes. Reactive paramagnetic species will be photochemically-generated in frozen solutions (where they are rendered unreactive) and will be studied with the W-band EPR spectrometer to obtain detailed information about their structures and roles in chemical reactions. These reactive intermediates will also be allowed to undergo bimolecular reactions on the time scale of tens of nanoseconds and longer in fluid media and will be monitored via time-resolved EPR spectroscopy.

Geology

(Prof. Odom, NHMFL-FSU Geology). Moving to higher frequencies and pulsed operation will facilitate the EPR application mineral dating and thermal stability. The current (X-band) limitations include the unresolved radiation sensitive signals, low sensitivity, and abundance of contaminating aluminum signal. Increased spectral dispersion, sensitivity, and signal editing by selective pulse sequences will alleviate these limitations and establish EPR as an analytical method of choice.

Environmental Science

(Prof. Landing, FSU Oceanography, Dr. Salters, NHMFL). W-band EPR (ENDOR) will be used to determine the structure of metal-organic ligand complexes in natural waters. Complexation of metals such as Fe or Cu by organic, humic substances regulates the bioavailability of the trace metals in the ecosystems. High sensitivity of the W-band spectrometers combined with larger shell of interacting nuclei is necessary to fully describe these complex geomacromolecules.

Physics

(Dr. Brunel, NHMFL). Spin distribution along the chains of the low dimensional cuprate polymers will be determined using W-band ENDOR. The hyperfine field at each site is proportional to the expectation value of the spin on a given site. Understanding the properties of low-dimensional spin systems will give insights into quantum disordered ground states and their excitations.

Advanced Magnetic Resonance Imaging and Spectroscopy (AMRIS) Facility Progress and Research Report #4, July 2000

Steve Blackband, Associate Professor, University of Florida Neuroscience Department

AMRIS Progress, July 2000

In the last report, updates were provided on the newly installed 11.7 T/40 cm MRI and 750 MHz wide bore NMR/MRI instruments, with both magnets achieving operating field strength in February 2000. The progress of these systems since April is briefly described in this report. The research report that follows is not really a standard report but rather a selection of images acquired on the 750 MHz over the last few weeks that illustrate its functional status and potential utility for imaging studies.

1. 750 MHz wide bore for NMR/MRI:
In the last report it was described how the magnet had achieved field, but that contact had been lost with one of the cryoshims. It was unclear at that time if the magnet could meet high resolution specifications. Since that time the Bruker engineer returned and successfully cryoshimmed the magnet without the use of the ZY cryoshim. This is fortunate since the repair of the cryoshim would most likely have required shipping the magnet back to Germany. With some effort the instrument then made high resolution specification on the 5 mm probe, and the engineer left the instrument in our hands. Although the instrument performs well for imaging, we quickly realized that the magnet has a problem maintaining homogeneity, falling substantially over a few hours and making the instrument at present unusable for high resolution spectroscopy. At present we suspect a fault in the room temperature shim control boards or power supply (touch wood). The Bruker engineer returns on the 25th of July.

In the meantime the instrument has been used for a variety of imaging applications testing soft and hardware. With the exception of a poor 5 mm rf imaging coil that will be repaired, the system is performing very well. Example images are given in the research report that follows.

2. 11.7 T/40 cm instrument for MRI:
The 11.7 T instrument made field in February but did not meet the homogeneity requirement. Subsequently an additional Z2 room temperature shim has been placed in the warm bore and the magnet is now well within specifications. With that achieved the final payment was made and we are awaiting the delivery of the corrected gradient coil so that Bruker can install the console and ancillary hardware. We have just heard that the gradients have been extended (the first set were accidentally too short) and are ready for delivery.

Subsequently we have had some problems filling the magnet with helium. The first time the Magnex engineer returned and successfully filled the magnet by venting to atmosphere. The next fill required the same fix and was performed in house. Just last week we again found ourselves unable to fill the magnet and discussions are ongoing with Magnex as to the cause of this problem. At present we believe we have a leak and subsequent ice block, but Magnex thinks otherwise. Either way another service call is in and this problem will need to be addressed during magnet warranty.

3. Other news—McKnight Foundation Gift:
We are pleased and grateful to announce that the Brain Institute has received a gift from the McKnight Brain Research Foundation. This foundation was established in 1999 by Evelyn F. McKnight to provide support for medical research of the brain in an effort to reduce the memory loss associated with aging and to make grants to charitable organizations involved in such research. The $15 million gift is to be used to support fundamental research intended for clinical application to help alleviate memory loss associated with aging. In recognition of this donation, the University of Florida Brain Institute will be named the Evelyn F. and William L. McKnight Brain Institute of the University of Florida.

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AMRIS Research Report #4 Preliminary Imaging at 750 MHz

Dan Plant, Tom Mareci, Xeve Silver, Steve Blackband, University of Florida
John Forder, University of Birmingham at Alabama
Helene Benveniste, Duke University

As described above, the 750 MHz has been working very well for basic imaging applications. In this report, a few examples are presented—mainly "pretty pictures" that illustrate the capabilities of the instrument. Unless stated otherwise the data were collected by Dan Plant, with spatial resolutions on the order of 40-100 microns. These data are part of the beginnings of ongoing research projects that may form complete reports in future newsletters.

Presently the instrument has available 5 mm, 15 mm and 30 mm diameter birdcage coils for imaging that have been used to image a range of ex vivo samples. (10, 20 and 25 mm coils have been ordered.) **Figure A** shows an image of a rabbit heart in the 30 mm coil with the left and right ventricles evident dark central areas surrounded by the heart tissue (heart provided by Dr Forder). The long term goal is to examine the ability of diffusion measurements to assess cardiac ischemia. **Figure B** shows an image of a small fish—note the exquisite detail in the eyes, where the retina and iris are evident. **Figure C** shows one axial slice from a multislice data set from a mouse brain provided by Dr Benveniste. The long term goal is to use such high resolution images to generate a mouse brain atlas. **Figure D** shows a saggittal slice from a rat brain demonstrating exquisite contrast between the brain structures. **Figure E** shows a section through a 3D image data set from an isolated

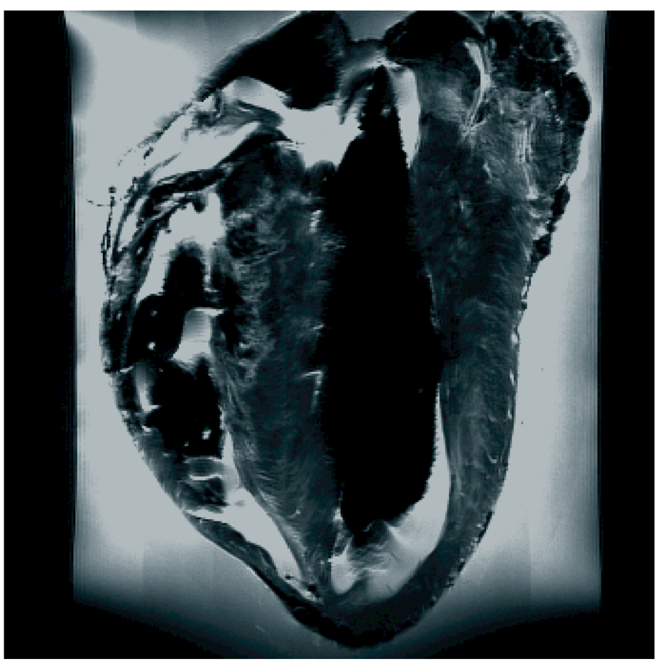

Figure A

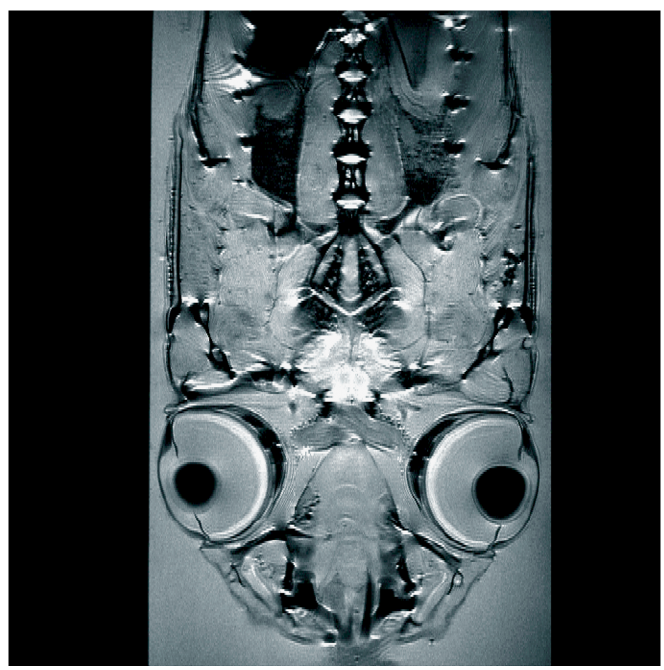

Figure B

rat spinal cord obtained by Xeve Silver and Dr Mareci. Dr Mareci and co-workers are using such data sets to assess damage in cords with contusion injuries, and to generate neuronal fiber maps in the tissue.

Overall the image quality is high and the SNR broadly as expected. We hope to quantify the gains obtained at 750 MHz by direct comparison with the 600 MHz at the NHMFL which has identical ancillary hardware. Over the next few months the instrument will be utilized for a wide variety of projects that will be described in future reports. The first in vivo experiments will be attempted in late July or early August.

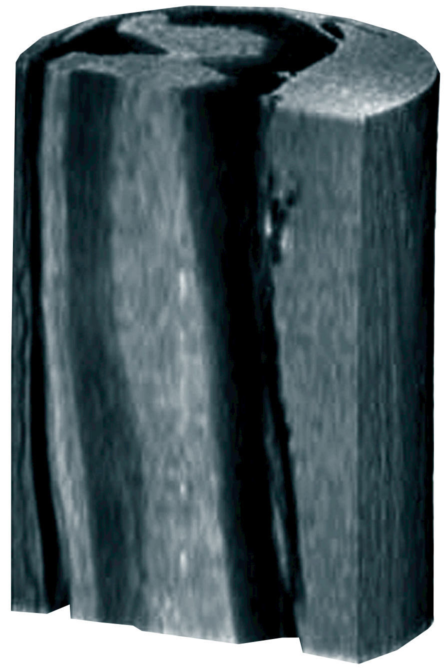

Figure E

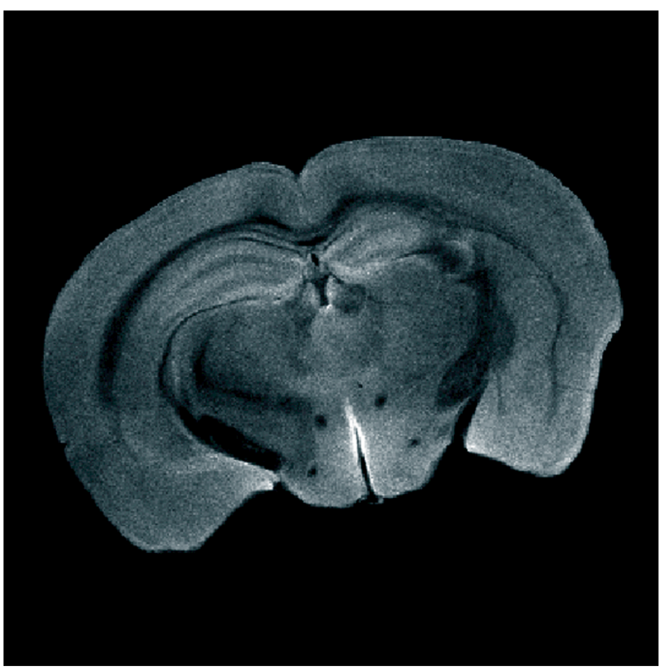

Figure C

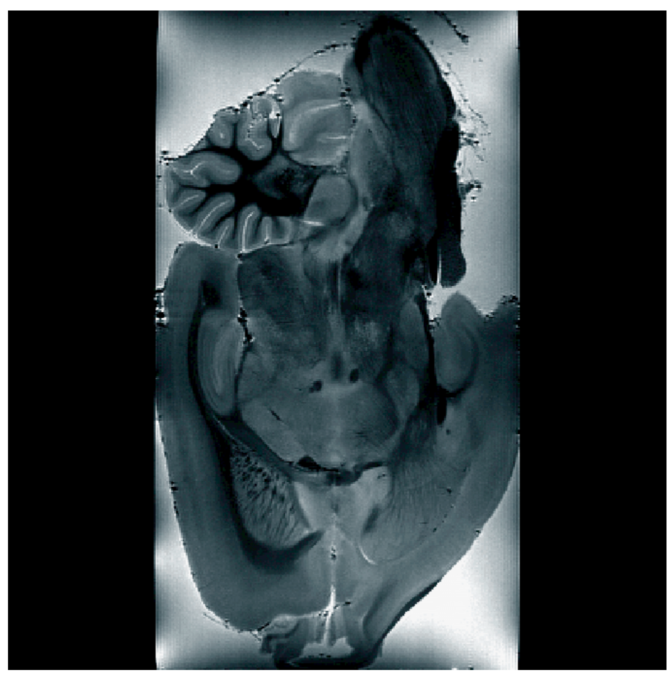

Figure D

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